

*The Holmes Safety Association*

# **BULLETIN**

*September 1997*

***INSIDE:***

*Mine fire preparedness*

*Selecting right explosives*

*Quarry safety programs*

*Custom drill rig*





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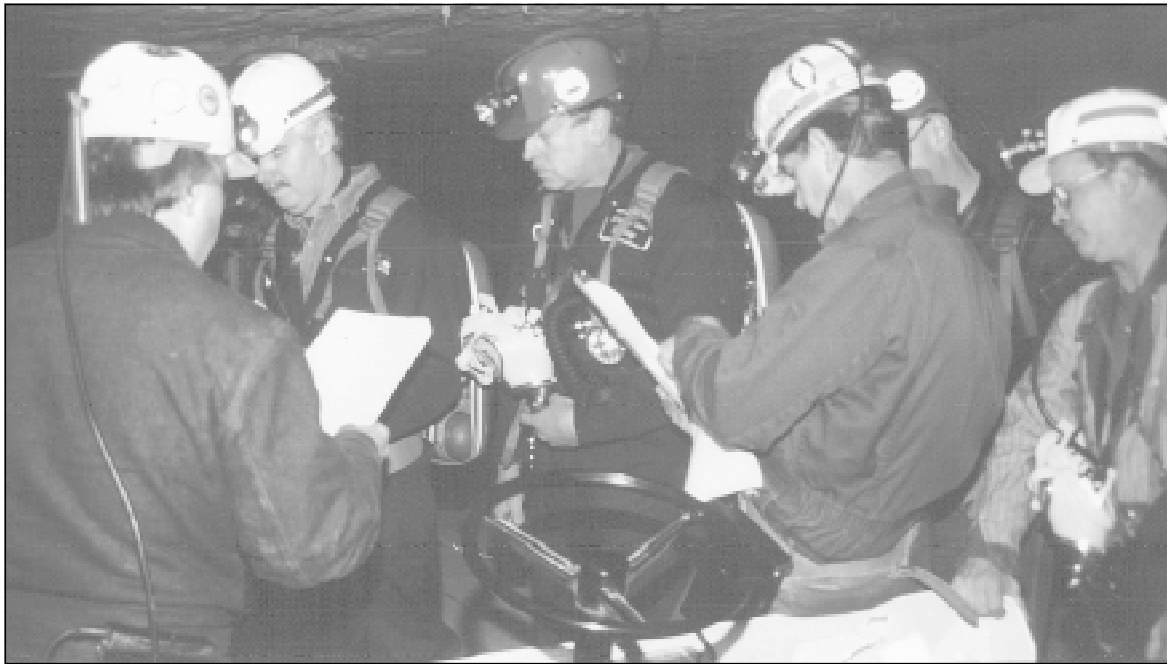
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The *Holmes Safety Association Bulletin* contains safety articles on a variety of subjects: fatal accident abstracts, studies, posters, and other health- and safety-related topics. This information is provided free of charge and is designed to assist in presentations to groups of mine and plant workers during on-the-job safety meetings.

**PLEASE NOTE:** The views and conclusions expressed in *Bulletin* articles are those of the authors and should not be interpreted as representing official policy or, in the case of a product, represent endorsement by the Mine Safety and Health Administration.

**COVER:** Thanks to Sturge Taggart of Ingersoll-Rand's (IR) Construction and Mining Division, Milwaukee, Wisc., depicts IR's newest drill—the ECM-570—generating only 96dB of noise. [If you have a potential cover photo, please send an 8" x 10" print to the editor, Fred Bigio, MSHA, 4015 Wilson Blvd., Arlington, VA 22203-1954]

**KEEP US IN CIRCULATION  
PASS US ALONG**



A briefing at the fresh air base for mine rescue teams.

## Underground mine fire preparedness

By Ronald S. Conti, Fire Prevention Engineer, William J. Wiehagen, Industrial Engineer, Richard S. Fowkes, Research Physicist, Charles Vaught, Research Sociologist, and Michael J. Brnich, Jr., Mining Engineer  
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### Part 4 of 4: Suggested improvements and implications for training miners in fire-fighting preparedness

This is the fourth and final article in a series that discusses underground fire-fighting preparedness. As with the previous three articles, it is based on interviews with 214 miners at 7 underground coal mines (referred to as Mines "A" through "G") conducted by researchers of the National Institute for Occupational Safety and Health's (NIOSH) Pittsburgh Research Center [Vaught et al. 1996]. The first article presented an overview of the study conducted by NIOSH on mine fire response preparedness and provided a general perspective on underground mine fires. The second article discussed miners' preparedness to evacuate a fire and their experience with incipient

fires. The third article described miners' experiences in fighting underground mine fires and presented their perceptions of training and readiness for fire-fighting. This final article in the series offers suggestions to improve mine fire-fighting preparedness.

One of the final questions that interviewers asked the 212 respondents (2 miners did not complete the interview) was what, in their opinion, could be done to improve fire-fighting response. Figure 1 shows that only 8% of the miners were satisfied with the fire-fighting training they were receiving, and a portion of them called for less complacency and more involvement by the rank and file. One-half of those individuals who felt that training at their operation was adequate were from Mine A, where hands-on practice was emphasized. Another 8% suggested that a formal discussion of techniques

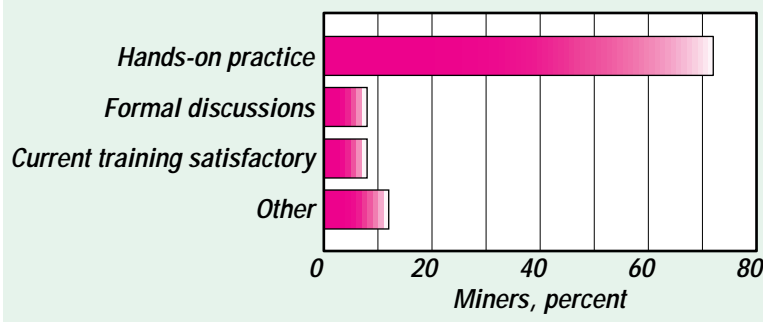
would be useful. One person even recommended that, in these formal discussions, management find a way to let workers draw upon their collective knowledge:

"Well, it might not hurt to have something once a month that was using all the experiences of every miner and what they had their biggest problem with and what they would have done to alleviate some [of the problem]."

Seventy percent of miners interviewed indicated a desire for hands-on experience, either in extinguishing a real fire or at least in handling fire-fighting equipment. Two miners commented:

"I'd say either hold actual drills... or have... somebody up on top show you the proper use of a fire extinguisher... There are a lot of people [who] don't know how to use them."

Figure 1.—Training improvements



“I think if they went to hands-on training, or even a special class—like so many people at a time and just let them use a fire extinguisher. Let them experience high-expansion foam. A section of people, they know about the fire suppression systems on different pieces of equipment, but to actually activate it, I don’t think there’s too many people that’s actually done it.”

A fire brigade member at one mine carried the notion of what would constitute good hands-on training a step further:

“Start out with several individuals per unit. Teach them at least the basics, as far as putting on the air equipment, the bunker gear, give them just the basics of really being a fireman... And that’s the key, as opposed to waiting 35 or 40 minutes for somebody else to show up. By that time, it could be so far out of control that it can’t be handled by anybody, I think.”

Apparently, most of the miners had given some thought to ways in which the work force could become better prepared to fight fires. Their suggestions ranged from simple ideas, such as seeing for themselves where various fire-fighting equipment is found at the mine to full-scale drills underground using nontoxic smoke generators.

Besides identifying ways in which training could be enhanced, most workers also suggested organizational and technological improvements that

might be made at their mine to enhance fire-fighting capabilities. Many of these items dealt with better communications and ranged from such things as developing a crew plan to regularly cleaning and maintaining signs. Other concerns voiced by some respondents were perceived shortcomings in equipment availability or a lack of adequate water pressure at their mine. Thus, although the need for hands-on training was uppermost in the minds of those miners interviewed, several thought of ways to augment this instruction by improving the system.

### System Improvements

In a mine fire, early detection maximizes the potential for escape from, and control of, the fire because more time is available to successfully execute these procedures [Kissell and Litton 1992; Conti and Litton 1992]. Generally, miners responding during the incipient stage of a fire (a fire too small to present a significant threat) increase their chances of extinguishing the fire, provided that they have adequate fire-fighting equipment and skills [Conti 1994]. To optimize the detection process, the choice of fire sensors (smoke, carbon monoxide, thermal) to detect a fire plays a major role. However, this choice is also tempered by the reliability and sensitivity of the detectors used. A related factor is the number of sensors required, because cost, both in capital expenditures and in labor needed to maintain a system, increases as the number of sensors increase. Several

mine fire detection research studies are reported in Conti and Litton [1993], Dobroski and Conti [1992], Edwards and Morrow [1995], Egan [1993], and Litton et al. [1991].

Additionally, an operation should have a preventive maintenance schedule in place to ensure that all detection and suppression devices work properly [Grannes 1988; Grannes et al. 1990]. Moreover, because early detection is of little value unless a quick response is mobilized, a mine should have an established warning and communication protocol that is tested and refined, as needed. Evacuation of personnel from an underground mine can require considerable time. Therefore, it is important that a warning alarm signal be able to quickly reach all workers underground and those on the surface [Hjelmstad and Pomroy 1991; Zamel 1990]. Recent research has shown that the alarm mode of commercial smoke sensors can be interfaced with a portable remote (wireless) transmitter to trigger either a partial or full mine-wide alert. This warning system is undergoing testing at NIOSH’s Lake Lynn Laboratory near Fairchance, Fayette County, PA [Mattes et al. 1983; Conti and Yewen 1997]. Preliminary test results indicated that underground receivers could be used to flash cap lamps and activate remote stations when an encoded signal was received. Examples of remote stations that could be activated might include strobe lights with audio outputs to indicate evacuation routes and the inflation of positive-pressure inflatable escape devices [Weiss et al. 1996]. This technology displays the ability to transmit from compact, portable, and semiportable receiving and decoding equipment. This paves the road to transceiver applications, such as emergency two-way messaging for refuge stations or mine rescue operations; remote monitoring of fire sensors and sump pumps; and remote control and monitoring of other mine equipment, such as conveyor belt systems and haulage traffic control.

Additional areas for research include transmitter designs for very large mines with and without adverse geology, vehicle paging and tracking, a motionless detector (to alarm if personnel become motionless) or a receiver with manually operated distress buttons, automatic "tag-in and out" with addressable paging numbers, and tracking of underground miners that could send out a beacon on command from a locator interrogator for mine rescue purposes.

Personnel must also be trained to properly respond to a warning signal from a fire detection system. When miners are not properly trained, the potential for disaster is imminent. As an example, on March 9, 1994 [Roberts et al. 1994], more than 180 feet of conveyor belt was destroyed at the Bullitt Mine in Virginia by a fire caused by contact between belting and an energized trolley wire. During the event, the carbon monoxide monitoring system responded at 9-ppm warning; however, the alarm warning was dismissed as "probably welding smoke." A short time later, the miner who was welding inadvertently discovered the fire while answering the mine phone. The miner immediately initiated fire-fighting activities. Typically, fire warning systems (smoke and carbon monoxide) respond to an incipient fire, but these responses are often dismissed as glitches in a sensor or planned maintenance activities in the area. It is important that any warning coming from an underground fire sensor be immediately investigated and that standard procedures are developed for responding to sensor warnings and alarms.

Water is the most practical and effective extinguishing agent. Once a fire has passed its incipient phase, a well-prepared operation will have adequate quantities and pressure plus the means to deliver the water to the fire site. Such a system would include large-diameter supply lines, portable fire hydrants, and high-pressure hoses with suitable nozzles [Conti 1994; Mitchell



*Extinguishment of liquid fuel fires with a wheeled fire extinguisher*

[1996]. Rather than the required minimum 50 gallons per minute water flow per hose, this system can deliver hundreds of gallons per minute (using several hoses) for sustained periods. Thought must also be given to water reserves. How long can fire-fighting efforts be sustained? In a review of the fire preparedness at four mines [Conti 1994], water supplies for underground fire-fighting were either large above-ground storage tanks, ponds, or rivers. One mine was fortunate to have an unlimited water supply. However, in another mine, only 900,000 gallons of water was available (15 hours at 1,000 gallons per minute). The water supply at this mine may not be sufficient to fight a large fire.

Another often overlooked area is water nozzles and water throw distance. Fire hose nozzles are important

components of fire-fighting equipment; however, many mines consider them a low-priority item. Several mines that experienced problems with plastic nozzles that either leaked or melted during fire-fighting activities have replaced plastic with brass nozzles. The water throw distance in underground mines is generally limited by the roof height, water pressure, hose size, and water nozzle. Therefore, throw distance in low coalbed mines would be shorter compared with a higher coalbed mine for the same water pressure, hose size, and nozzle.

When an underground mine fire cannot be directly combated due to heat, smoke, or hazardous roof conditions, high-expansion foam may be one way to remotely quench the fire. Foam is a convenient means of conveying water to a fire [Havener 1975]. It blocks air currents to the fire and radiant energy from the fuel. High-expansion foam cannot control a fire unless the foam plug reaches the fire. To effectively use the foam method for remotely fighting fires in underground mine entries, it may be necessary to construct a partition or seal in fresh air some distance from the fire site. This is done to separate the foam generator and its operators from smoke and toxic fire products. In addition, foam could flow back over the foam generator, rendering the fire attack ineffective. In past practice, concrete block, wood, plastic sheeting, brattice, or similar materials have been used for such



*Storage of mine fire hose.*

# 6

partitioning. Building these partitions can be labor-intensive and time-consuming. An inflatable feed-tube partition for high-expansion foam generators was developed [Conti and Lazzara 1995]. The inflatable partition is a lightweight, portable, rectangular inflatable bag that can be used by fire-fighters to rapidly seal large openings, such as those in underground mines, and to simultaneously provide a feed tube for a high-expansion foam generator. Additional information on the use of foam and partitions can be found in Mitchell [1996] and Conti [1994, 1995].

facilities and equipment can never compensate for poor preparation." A large part of mine fire preparedness, therefore, is worker capability. A large part of worker capability is experience, motivation, and training. One of the most interesting observations from the interviews of 212 underground miners is that 45% of these miners reported having dealt with a fire that could have gotten out of hand. Additionally, 30% of the respondents were involved in at least one incident that they believed might better have been handled differently. It appears from these statistics that, although there are many

the preceding 15-year period [McDonald and Pomroy 1980]. Industry efforts to provide better fire protection has played a significant part in this trend. At the same time, the number of mining jobs has also declined partly due to fewer operating mines. It can be argued that these factors have caused a change in people's thinking. At one time, miners might have held the notion that if their mine were sealed due to a fire, they could go to work at another operation. Now they are more likely to regard sealing the mine as an end to a career in mining. Whereas miners might once have been reluctant to endanger themselves in a fire-fighting effort, they are now more likely to think about saving the mine in order to save their jobs. Each incident that occurs, therefore, may be dealt with by a group of first responders intent on extinguishing the fire. Thus, it becomes critical to first understand their capabilities and then to enhance them, where necessary.

In a sense, each occurrence of fire underground, no matter how small, presents a teachable moment for the work force. Safety and training personnel should consider recording the particulars of these events to assess what was done correctly and where mistakes were made. Teaching points could then be derived and passed on in safety talks or embedded in fire drills. Thus, miners at an operation would be exposed to ongoing learning opportunities that draw upon things that have actually happened to people whom they know in their own work setting. Another use of such a compilation would be as a data base to indicate, over time, whether improvements in worker responses were being achieved.

A major drawback to learning fire response procedures "on the job" is the lack of structured practice. There are some aspects of fire preparedness that require cognitive knowledge, and others that demand motor task skills. Safe evacuation, for instance, depends on knowledge of a mine's escapeways. However, at three of the sites in this

*Extinguishment of a 400 square-foot liquid fuel fire.*



### *A proactive strategy*

Because detecting and extinguishing a mine fire may require the involvement of a complex system, current research is aimed at developing and evaluating formal fire preparedness checklists. The chief advantage of such a strategy, using a carefully defined and preset protocol, is that it could highlight any strengths and weaknesses of a site in some systematic way. In addition, there would be less chance that problem areas might go undiscovered and therefore uncorrected. A few of the topics that we cover in the checklist include a complete evaluation of the mine water system, fire-fighting equipment, supplies and responders, detection and suppression systems, housekeeping, and the use of fire-resistant materials.

Mitchell [1996] states that "the best

successes, there is also room for improvement in how people respond to fires underground. A very interesting observation concerning training needs, in view of this fact, was made by the person who suggested that companies find a way to let workers learn from others' experiences.

### *Perspective*

Over the past 2 decades, the number of reportable underground coal mine fires has significantly declined. As mentioned in the first article of this series, a total of 164 fires were investigated by the Mine Safety and Health Administration (MSHA) from 1978 to 1992 [Pomroy and Carigiet 1995]. An additional 25 fires were investigated in 1993-95. This is an average of 10.5 fires per year, compared with 32.4 fires per year for

sample, a sizable portion of those interviewed had not walked their escapeways within the past year. A successful attempt to put out a fire might well hinge upon the responder having some skill in the use of a fire extinguisher. Many miners sampled, however, had only used one in an emergency. That is hardly the situation in which to learn good technique. However, the percentages of miners that had some fire response training as either a volunteer fire-fighter or as part of a mine fire brigade are perhaps reflective of firms encouraging employees to expand upon skills that may be of direct, long-term benefit to both the work organization and the community.

It appears from the data gathered in this study [Vaught et al. 1996] that there are two types of missed opportunities at some operations. On one hand, good fire drills could incorporate not only an opportunity to learn from the experiences of others through discussions or reenactment of past

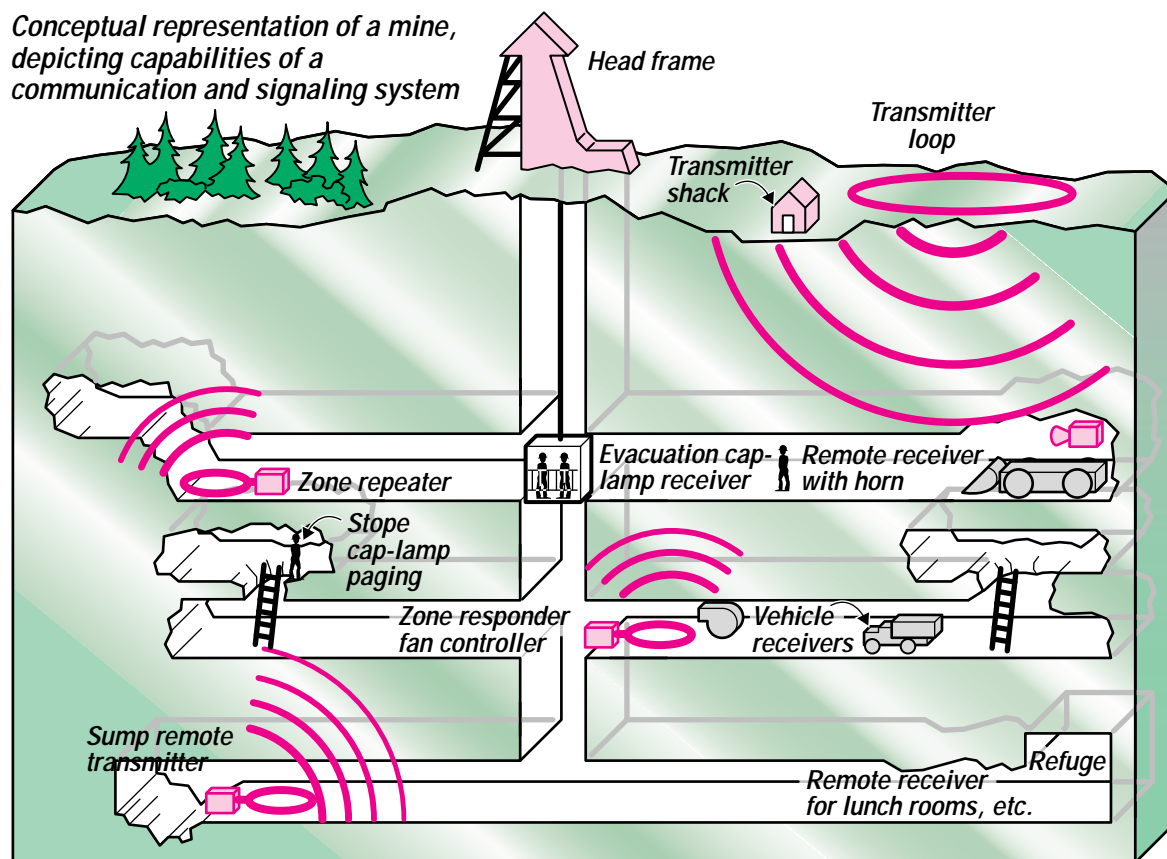
incidents, but might also provide a variety of hands-on experiences in using emergency equipment as well. The better structured and preplanned they are, the more teaching that could take place in a reasonable timeframe. On the other hand, occurrences of incipient fires provide opportunities to look back, evaluate, and enhance prevention, detection, and response capabilities.

By and large, the picture that emerges from this study is one of variability from mine to mine. Significantly greater percentages of interviewees had walked their escapeways at some operations than at others. The same was observed for those who recently participated in fire drills. The broad types of training offered to the work force also varied, with some mines relying heavily upon discussions and lectures as the main vehicle for developing fire response skills. Some mines tended to more formally integrate learning from their ongoing fire and smoke experience as a means for maintaining fire prevention,

detection, and response communications within the work force. With little variability, all mines seemed to take the threat of smoke and fire seriously. However, the median frequency of reported smoke at two mines was at least once per week, whereas at another it was about once per year. The most consistent part of this picture is captured by the percentage of miners (70%) across all seven mine sites who have, at some time during their career, fought a fire underground. This suggests that fire is a constant (i.e., fires will always occur).

At times, little difference is found during the incipient phase between most fires that go unreported and one that results in a mine being sealed. It is simply that the latter either were not detected quickly enough or were not responded to properly. To achieve enhanced mine fire preparedness, mining companies will need to sharpen their strategy with regard to available technology and equipment while investing increased time and effort in

Conceptual representation of a mine, depicting capabilities of a communication and signaling system



*Flammability  
of ventilation  
tubing.*



their human resources. In other words, a growing number of mine sites are preparing themselves to deal with the unexpected. If these efforts continue, the number of reportable incidents will likely decline even further, and there should be even less chance of another disaster or permanent mine sealing.

In short, long-term, systematic improvements in mine fire preparedness imply a complementary focus on technology and the performance of this technology within the work site. An important premise of the work summarized in this series of articles is that the ongoing study of how miners make use of critical prevention, detection, and response systems offers important insight into both incremental and breakthrough technologies (engineering, education, and public policies) to enhance worker safety and health.

### *Summary*

The following summarizes the key points in this series of four articles:

- Although the number of underground coal mine fires has dropped drastically in recent years, the potential for disaster is still present when a small mine fire occurs. Even a small fire causes disruption of production, which

can be costly. Thus, it is important to have a work force that is well trained to prevent, detect, and fight a fire and for miners to know their escape routes and mine evacuation plan.

- A mine fire can occur at any time in any place with any of the equipment, causing partial or total evacuation of mining personnel two-thirds of the time.
- Approximately 85% of reported fires were first detected by mining personnel who saw smoke, smelled smoke, or saw the fire start.
- Water is still the most used fire suppression agent for fires beyond the incipient stage.
- Elapsed time between the onset of a fire and its detection is critical because fires tend to grow quickly in size and intensity.
- The ability of workers to effectively use fire suppression equipment is a critical component of preparedness, and a large part of worker capability is experience, motivation, and training.
- The percentage of miners who said that they had been caught off guard by the sight or smell of smoke in the last 6 months ranged from 18% to 68%, depending on the mine.
- The most commonly cited sources of smoke were belt rubbing and hot metal.
- Approximately 21% of the miners said that they had donned either a filter or a self-contained self-rescuer in an emergency.
- Approximately 70% of the interviewed miners had been involved in helping extinguish a mine fire (regardless of the size) during their mining career.
- About 8% of the miners felt that their current mine fire-fighting training was satisfactory.
- Across the seven mines, approximately 72% of these miners indicated a desire for hands-on training either in extinguishing a fire or at least in handling fire-fighting equipment.
- There were large levels of variability among the seven mine sites, as follows:
  - Significantly greater percentages of miners had walked their escapeways at

some operations than at others. The same holds true for those who had participated in fire drills.

- The percentage who had to evacuate a mine one or more times because of a fire ranged from 20% to 67%.
  - The broad types of training offered to the work force also varied, with some mines relying heavily on discussions and lectures as the main vehicles for developing fire response skills.
  - The percentage of miners who had hands-on training (practicing with fire-fighting equipment) ranged from 15% to 85%. Those who had lectures (being told what to do) ranged from 45% to 90%, and those who had discussions (talking about it) ranged from 45% to 80%.
  - The percentage who felt that they had an acceptable level of fire-fighting skills ranged from 57% to 89%.
  - The median frequency of reported smoke at two mines was at least once per week, whereas at another mine it was about once per year. However, all mines took the threat of fire seriously.
- Facilities and programs for mine personnel to learn about the hazards of mine fires, evaluate modern fire detection and fire-fighting equipment and technologies, and observe the proper methods to combat mine fires are sparse. Recent mine fire application seminars and briefings sponsored by MSHA at its National Mine Health and Safety Academy in Beckley, WV, the West Virginia University Mining Extension Service [Moser 1993], and NIOSH at Lake Lynn Laboratory [Mattes et al. 1983] are positive steps. Increasing the mining industry's awareness of the dangers of underground mine fires could reduce the risk of a major fire and improve the current state of fire preparedness.

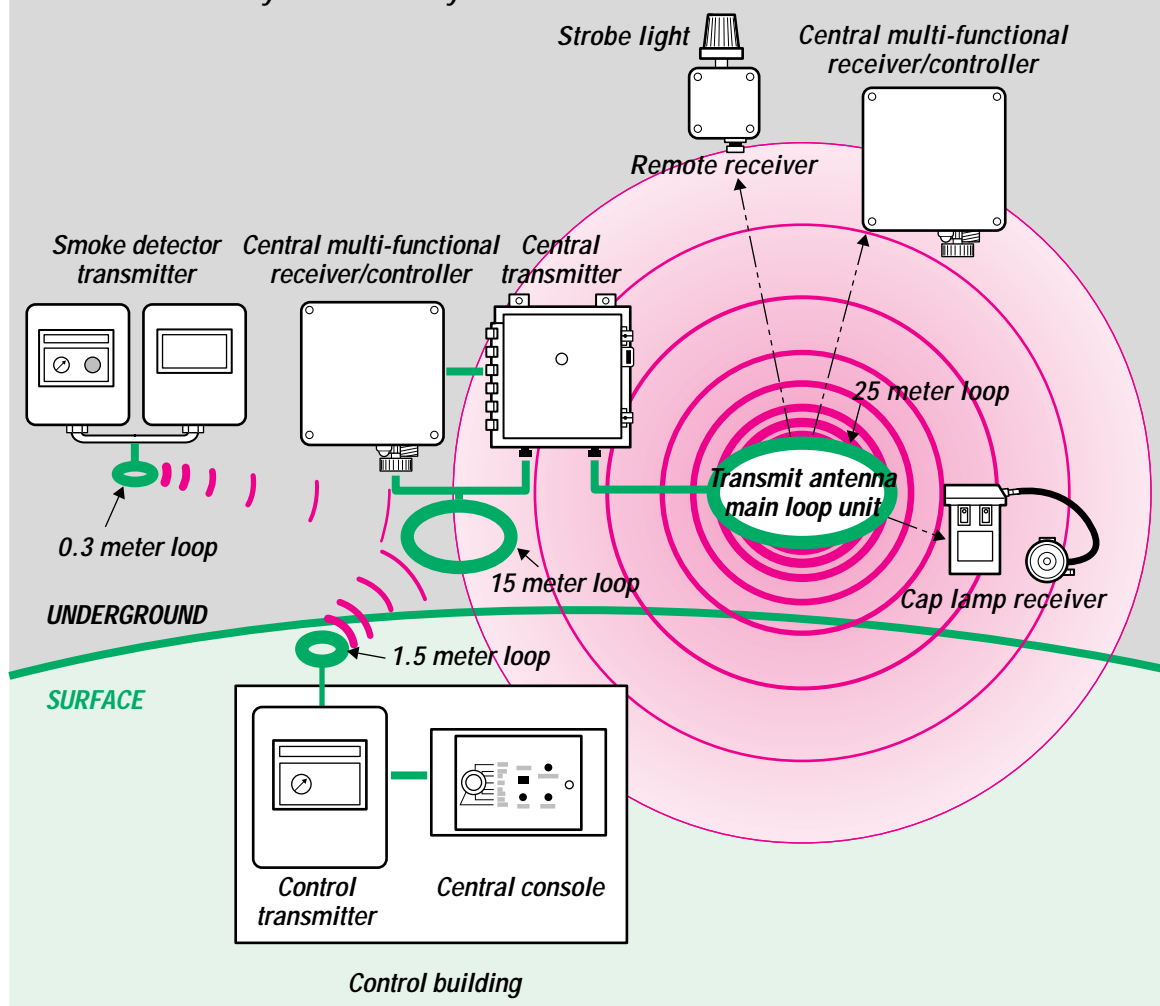
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Flow chart of Lake Lynn's antenna system



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## Selecting the right explosives

*Picking the blasting products that are best for your operation requires a thorough evaluation of explosive and drilling costs.*

By Lyall Workman

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In recent years an increasing variety of explosives have become available to quarry and mine blasters. Selecting an explosive has, therefore, become more of a challenge as one tries to find, among the various choices, the product that will be most effective operationally and economically.

There are essentially four classes of explosives that the quarry manager will choose from. These are:

- ANFO.
- Heavy ANFO.
- Emulsion.
- Slurry.

The chosen explosive is usually bulk-loaded. However, some quarries drilling small diameter holes, such as 3-in., may use cap-sensitive, packaged, small-diameter explosives.

### ANFO

ANFO is a combination of ammonium nitrate and fuel oil. It is the most commonly used explosive in open pits. A blasting grade porous prill is used that has sufficient porosity to absorb 6 percent by weight fuel oil and hold it for extended periods of time.

When ANFO contains other than 6 percent fuel oil by weight, the energy output of the product reduces. This is shown in Figure 1. ANFO that is fuel lean results in the production of nitrogen dioxide gas (NO<sub>2</sub>) upon detonation. This gas is reddish brown in color. Hence the orange fumes that you may periodically see emanating from the blast area.

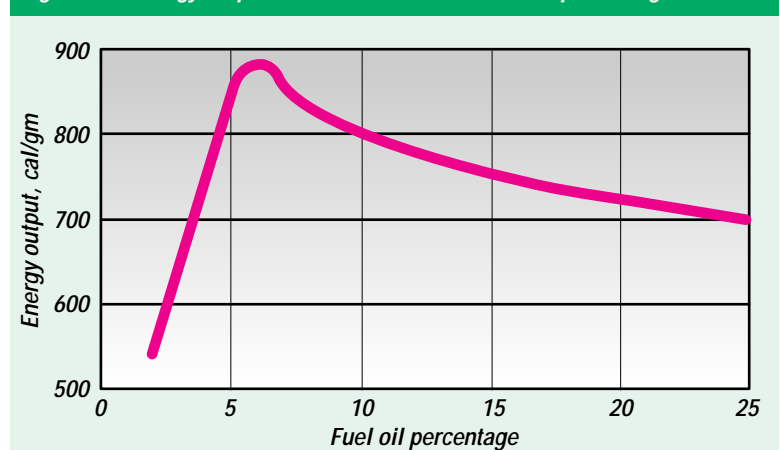
The occurrence of orange fumes means that the bulk truck is out of calibration and not providing adequate fuel, or water attacked the ANFO. For optimum performance, calibrate the

bulk trucks frequently and keep the ANFO protected from water.

There are laboratory procedures available for checking the fuel oil content of ANFO. There are also field kits that allow testing of the quality at the blast site. When you use field kits to check the calibration each time the truck is used, there is little chance of a blast being loaded with poor quality product.

Ammonium nitrate (AN) has virtually no water resistance at all. ANFO that is loaded unprotected into a wet blasthole experiences immediate

Figure 1.—Energy output of ANFO for different fuel oil percentages



water attack. It is a fallacy to believe that shooting holes a few hours after loading makes it alright to load ANFO into a wet hole without first pumping it and placing a blasthole liner.

Liners should be free of pinholes. For best results, use liners heat-sealed on the bottom. A blasthole that is making water so rapidly that it cannot be properly pumped, lined and loaded before it again contains appreciable water usually requires a waterproof explosive.

For some operations, the rock is too hard to be properly fragmented using ANFO. For these formations, the energy output can be increased by adding aluminum to the mix.

Aluminum additions usually range between 5 and 15 percent by weight.

Generally, there is no advantage to using more than 15 percent Al. The formation of increasing amounts of a solid aluminum oxide product of detonation at high Al contents traps greater amounts of the energy output. Consequently, above 15 percent the cost-benefit ratio tends not to be attractive.

A recent trend in ANFO use is to replace about 50 percent of the fuel oil with used lubricating oils. To use waste oil you must first submit a petition for modification to MSHA.

A successful petitioner for modification has good testing and handling procedures and will only use oils generated on the property. Advantages include the elimination of costly transportation of used oil to proper disposal sites and the avoidance of potentially costly, long-term liability for mismanaged sites.

### Emulsions

Emulsions are similar to the earlier developed slurry explosives. However, instead of a cross linking agent to gel the mixture, an emulsifying agent is used. Therefore, a basic emulsion consists of an oxidizer solution of ammonium nitrate (and may also contain calcium or sodium nitrate),

a fuel, an emulsifier and entrained gas. The gas is introduced either mechanically using microballons or by chemical gassing agents.

The entrained gas provides density control and adds the sensitivity necessary for reliable, efficient detonation. Small diameter and all packaged products are mechanically sensitized.

However, large hole products can be sensitized in either manner. Mechanical sensitization is generally more stable, but there is a cost advantage to the chemical method.

A water-in-oil emulsifier is used. Upon shear mixing of the oxidizer and fuel, the oxidizer solution disperses as minute droplets throughout the fuel phase.

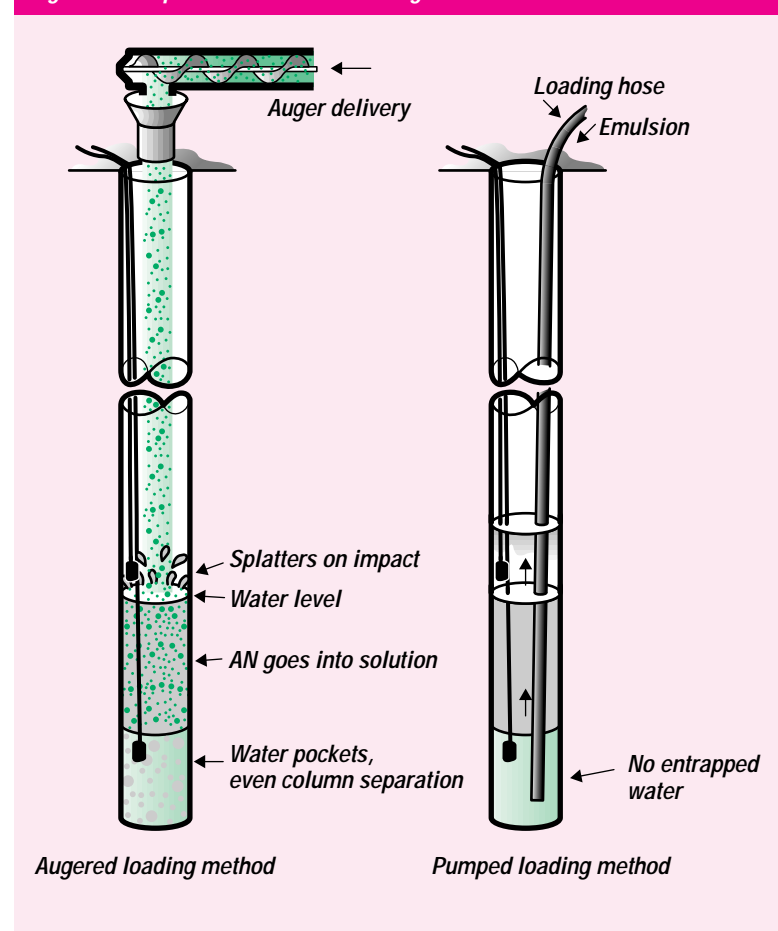
The intimate mixing of fuel and oxidizer resulting from the dispersion of the oxidizer in the fuel

gives emulsions some of their properties. These include a rapid rise to characteristic detonation velocity with increasing diameter, and an actual detonation velocity near to the theoretically calculated value.

These properties tell us that emulsions can be specially useful in hard brittle formations where more of the fragmentation is associated with the initial shock wave. These products are also good for secondary oversize blasting because the lack of confinement means we are dependent on the shock off the end of the charge to shatter the rock.

Emulsions are waterproof, and therefore used in wet hole applications. These products are produced at a higher density than ANFO, so the bulk strength (energy output on

Figure 2.—Top and bottom hole-loading of HANFO.



an equal volume basis) is greater.

Blast patterns expand in the same rock relative to ANFO, which can improve economics in formations experiencing high drilling costs. Emulsions are useful products when you need more energy to achieve adequate fragmentation.

### Heavy ANFO

Heavy ANFO (HANFO) is a mixture of emulsion and ANFO or AN. The emulsion fills the voids between the AN prills. Consequently, the density and bulk strength of the blended product are greater than ANFO. Today, it is probable that HANFO is the second most commonly used explosive after ANFO.

HANFO can be used with varying percentages of emulsion to increase the bulk strength to match well with the rock being fragmented. At approximately 50 percent emulsion, the explosive becomes waterproof. However, HANFO containing so much solids is hard to pump reliably; therefore, many waterproof HANFO's contain 60 percent or more emulsion.

Adding increasing percentages of emulsion means more and more air is forced out of the system. Research shows that the resulting product has decreasing performance, unless you use a sensitized emulsion. All waterproof HANFO must use sensitized emulsion for proper performance. In hard rock it is likely that HANFO containing more than 30 percent unsensitized emulsion will result in reduced performance, as detonation velocity and borehole pressure are significantly reduced from calculated values. For softer rock it is usually possible to use higher percentages of unsensitized emulsion before problems develop.

Load waterproof heavy ANFO into wet holes by extending a hose to the bottom of the hole. Keep the hose in the explosive and retract as

loading progresses. Water is carried up on top of the explosive and does not mix with the product.

Some have augured HANFO into wet holes. This procedure results in spattering as the explosive impacts the water. AN goes into the solution. Water becomes included in the mix, and bridging can occur leaving water gaps in the explosive column. Marginal detonation or outright failure of the explosive often results. Figure 2 compares top and bottom hole-loading of HANFO in wet holes. You should also load bulk emulsions and slurries from the bottom up in wet holes.

Heavy ANFO is often bulk loaded using "triple threat" trucks. These units include storage for AN, fuel oil and emulsion. ANFO, HANFO or emulsion can be provided. Trucks may have both auger and hose loading capability. Some have provision for adding sensitization.

### Slurries

Slurries are a combination of oxidizer solution, fuels, sensitizers and a crosslinking agent. These explosives are quite similar to emulsions in formulation, except for the use of the crosslinker. Some slurries contain a high explosive sensitizer like TNT.

Slurries are less common in use now than in the past. They have been replaced in many applications by emulsions. Many manufacturers in the USA who previously made bulk slurries (also called water gels) no longer do so. There are still a few that do, and several make packaged products. There appears to be more bulk slurry use overseas.

The crosslinker used in these explosives causes them to set up quite stiffly. Therefore, in very wet conditions they may have an advantage over emulsions. However, the mixing between fuel and oxidizer is less intimate than with

emulsions so maximum VOD occurs at larger diameter and does not approach the theoretical velocity as closely as emulsions do. This will be a drawback primarily in hard rock application.

Slurries that do not contain high explosive require sensitization just as emulsions do. The sensitizer can be microballons or a chemical gassing agent. Gassing agents are most common in larger diameters. Critical diameters become large if the density is not regulated in order to account for the overpressure generated by self loading of the slurry and stemming.

Slurries are made at a higher density than ANFO.

Therefore, these have a higher energy output than the dry mix. Thus, they can have advantage when the rock formation is hard. Slurries containing TNT have quite high densities because they are less sensitive to overpressure.

Today, the blaster has a wide variety of explosives from which to choose. Technical factors in explosive selection include rock strength, blasthole diameter, and the presence of water among others.

To choose the most economical product you must analyze both the explosive and drilling costs associated with each potential choice. Drilling costs must be included because explosives with different energy output require different blast patterns.

This means the drilling costs will not be the same for all choices. Remember also that the cheapest D & B cost does not always mean the lowest cost operation. Total mining cost may very well increase if blasting cost reduction is obtained at the expense of blasting performance.

*Reprinted from the July 1997 issue of Pit & Quarry*

## A custom drill rig

A Kalgoorlie [Australia]-based drilling company proprietor has taken delivery of a new reverse circulation drill rig he designed, which has features which will not only help to reduce the occurrences of accidents, but also increase productivity and versatility.

The big difference between this drill rig and other rigs, is that this rig has been designed around the features that the driller wanted. In nearly all other rig designs the designers have built the features around the conventional rig design, i.e., a drill mast, power pack, compressor, hydraulics, rod rack, and everything else you could think of, mounted on the back of a flat bed truck.

This drill rig is radically different from most others in several aspects.

The innovative design of this rig has been examined closely and the Department believes that the risks associated with a number of readily identified hazards have been much reduced.

The following are some of the features which are believed to reduce accidents and improve productivity.

- The drill rig uses a dump truck chassis and running gear. This allows a robustly designed structure that readily accommodates the other components

and systems used on the rig.

- The drill mast is offset to the left of the rig to allow a rod handling system to be used. The rod handling system consists of a magazine capable of holding 400 meters of drill rods. The magazine is positioned along side the drill mast in a convenient location by means of hydraulic rams similar to those for the mast itself. A small crane jib with a hoist installed on top of it are used to lift and lower drill rods as required. The crane jib can be raised or lowered and slewed left or right. These functions are all controlled by the driller at the main control panel. The system allows the driller to have constant visual contact with what is happening and the offsider stands along side the driller during the rod handling process, and does not have to carry out the hazardous job of "running with the rod".

- Manual rod handling on conventional drill rigs is inherently hazardous and this task results in a large proportion of injuries that occur at drilling operations. It is believed that the system used on the rig reduces the risks and hazards to the drill crew. The development of this type of system was recommended in the 1992 study on fatal accidents.

- Currently only the booster compressor is mounted on the drill rig. At a later date there will be a compressor package installed along side the booster. The high pressure air from the booster is hard plumbed on the drill rig structure. This means that currently, only the compressor delivery hose is run between the compressor package and the drill rig. This also reduces risks from hazards associated with high pressure air hoses.

- The cyclone and sample splitting system installed in the side of the drill rig is fitted with a knife valve to control the dumping of sample material through the splitter. The moving parts of the valve are hidden within the rig structure to keep them away from the drill crew to prevent injuries due to inadvertent contact. The cyclone is made from polyurethane which allows easier removal and cleaning of internal sample build up.

- The rig has a large water tank, installed with retractable water and air hosing to allow cleaning and maintenance of the cyclone or other parts of the rig as required.

Because of the large rod carrying capacity, large water tank and a fuel tank with enough fuel to run the rig for 10 days, a support truck is not required to be present with the rig every day.

There have been a number of design and operational improvements made to rigs in recent years.

This rig incorporates many well designed improvements which may be of interest to the industry.

For more information, contact Brett Boneham on Tel: (08) 9021 9428

Reprinted from the May-June 1997 issue of *MINESAFE*, published by The Mining Operations Division 6th Floor, Mineral House, Department of Minerals and Energy Western Australia, 100 Plain Street East, Perth, Western Australia 6004. Editor: Catherine Stedman, Tel: (08) 9317 3485



Far left: Rear of rig with the rod handling system in use. Left: The drill rig from the lefthand side of the rig towards the rear.

## NIOSH primer offers practical tips

Practical tips for protecting workers from job-related muscle strains and injuries are highlighted in a new document from the National Institute for Occupational Safety and Health.

“Elements of Ergonomics Programs: A Primer Based on Workplace Evaluations of Musculoskeletal Disorders” outlines common ways to identify, correct and prevent work injuries.

“The NIOSH primer is a unique resource for anyone who seeks information about practical and cost-effective ways to prevent these injuries and illnesses,” said Dr. David Satcher, M.D., the director of the Centers for Disease Control, NIOSH’s

parent organization.

Ergonomic-related disorders of the upper extremities account for more than \$2.1 billion in workers’ compensation costs, while lower back problems cause another \$11 billion in worker comp expenses a year. The primer describes seven basic steps for controlling these work injuries—determining if ergonomic problems exist at a work site; developing roles for both managers and workers in a formal program; training; gathering and analyzing data; developing control solutions; establishing health care management; and creating a proactive ergonomic program.



Reprinted from the Vol. 10, No. 10; May 19, 1997 issue of *Mine Regulation Reporter*. Copies of the booklet are available by calling 1-800-NIOSH (1-800-356-4674). You can also visit the NIOSH Homepage at [cdc.gov/niosh/homepage.html](http://cdc.gov/niosh/homepage.html).

## NIOSH to publish mining insights

Look for NIOSH to soon publish proceedings of the national ergonomics conference from earlier this year in Chicago.

The mining sessions at the two-day gathering examined successful mining programs. Tim Martin of **American Electric Power's** Fuel Supply Div. showed how mining companies reduced accidents, reduced worker compensation and cut down time.

Injuries at AEP's Fuel Supply

Division dropped from 67 in 1989 to only 8 in 1996 largely because of the ergonomics process. Martin and Dan Anderson of CONSOL noted that many ergonomic fixes are simple and inexpensive.

The tips include:

- Reduce the weight of frequently handled objects to prevent back injury.
- Keep timbers dry. Water-logged timbers can weigh 20 to 40 pounds more than dry ones.

- Rely more on hoist mechanisms to help in lifting timbers and other heavy objects.

Remember hernias, from lifting or pulling, are consistently the most common form of injury in all categories of mines.

For more information, call Sean Gallagher of NIOSH at 412-892-6445.

Reprinted from the May 19, 1997 issue of *Mine Regulation Reporter*—Vol. 10, No. 10, by Pasha Publications Inc.

## Working in confined spaces

A confined space is defined as any space or structure which by design has limited openings for entry and exit, and which is not intended for continuous employee occupancy. A confined space has poor natural ventilation. Confined spaces include storage tanks, pits, silos, vats, boilers, ducts, sewers, pipelines, and other structures found at metal/nonmetal mines. A confined space which is immediately dangerous to life or health (IDLH) includes those with oxygen deficiency, explosive or flammable atmospheres, or high concentrations of toxic substances - and requires the most demanding protective measures. Any operation which generates toxic contaminants within a confined space, without proper control measures and precautions, may be dangerous to life within a short period of time.

When work is planned within a confined space, the supervisor and the miner who is to carry out the work should have an understanding as to the work to be done, the hazards that may arise, and the necessary protective measures to be taken. A work permit which contains this information in writing is highly recommended. This will provide authorization for the work, and requires that the supervisor and employee review the operation, hazards and control measures before entry and before the operation is started.

Protective and precautionary measures for work in confined spaces should involve as a minimum, the following:

**1. Atmospheric testing and monitoring.** Prior to entry, initial testing of the atmosphere should be carried out from the outside. Such tests should include those for oxygen content, flammability, and toxic contaminants. In accord with MSHA regulations, the oxygen content shall be at least 19.5%. If it appears that an atmosphere immediately dangerous to life may

develop, it is essential that a safety belt or harness and a life line be worn by the person in the confined space. A standby person must be in attendance.

**2. Training of personnel.** Employees who are to work in confined spaces should be adequately trained. Such training should include understanding of the hazards involved, entry and exit procedures, safety equipment, emergency first aid, control measures such as ventilation, use of appropriate respirators if required, and proper work practices.

**3. Standby person.** When work is conducted within a confined space, a standby person should be stationed on the outside. This person should be trained in emergency rescue and first-aid procedures, and should have communication equipment as necessary for contact with those working inside, and for immediate contact with medical, ambulance, fire fighting, and other rescue personnel if needed. MSHA regulations require that such person be present if the atmosphere in the confined space is dangerous (IDLH). The standby person should be familiar with and have available appropriate respiratory protection equipment.

**4. Safety equipment and clothing.** Employees working in confined spaces must have available and use appropriate safety equipment and clothing—such as eye and face protection, proper gloves and full-coverage work clothing where indicated, and safety belt or harness with lifeline in dangerous atmospheres. MSHA regulations have specific requirements for such safety equipment and clothing. Hearing protection in the form of ear plugs or muffs is required where noise levels exceed MSHA standards. Personal respiratory protection may be necessary if ventilation is not sufficient to control contaminants to the permissible exposure limits. This may be in the

form of supplied-air respirators or self-contained breathing apparatus and is recommended where contaminants from welding, painting, solvent cleaning or other operations generating toxic contaminants are involved.

**5. Warning signs.** Warning signs of a confined space and the hazard should be posted near entrances. When work is not in progress, the entrance should be blocked. When work is in progress, the standby person should ensure that unauthorized persons do not enter the restricted area.

**6. Purging and ventilation.** Purging of the confined space to remove contaminants should be done before entry by means of a high rate of general ventilation. Atmospheric testing is then in order. Atmospheric testing is then in order. The main environmental, or engineering, control of suspected or known contaminants during operations is general ventilation. Design of the system will vary. Continuous general ventilation is recommended for most operations where contaminants are generated. This may be supplemented or replaced by local exhaust ventilation. Personal respiratory protection may be required in addition to general and/or local exhaust ventilation. Monitoring of contaminants during operations is indicated if there is doubt about the effectiveness of controls.

Attention to the protective and precautionary measures outlined above is essential for assurance that exposures within confined spaces are controlled.

If you have any questions about this or any other occupational health matter, feel free to ask us. Our job is protecting your health.

URL: <http://www.msha.gov/S&HINFO/HHICM02.HTM>  
Contact: Mine Safety and Health Administration, Metal and Nonmetal Health Division, 4015 Wilson Boulevard, Arlington, Virginia 22203-1983, Phone: 703-235-8307

# The aging miner population

The U.S. mining work force is aging. USBM data on the mining work force in 1986, the last year detailed numbers are available, gave these statistics: there were a total of 146,395 coal miners in 1986, of whom 34,441 were between the ages of 40 and 49 (23.5%), and 23,459 who were over 50 years of age (16.0%). This means that 57,900 coal miners, or 40% of the total, were over 40 years of age in 1986. The mean age of all coal miners in 1986 was 39 years.

In 1992, the mean age of coal miners was 42 years. It is likely the average age of the mining work force has increased since these data were compiled.

This aging miner population has implications on such factors as endurance, strength, reflexes, the back, hearing, eyesight, etc. The deterioration of these factors can affect the safety and health of miners, meaning that human engineering techniques have an important role in developing new equipment or systems and redesigning tasks to compensate for the physical decline of the body with age. However, most underground mobile mining equipment appears to have been designed without considering age as a significant factor. It is important to understand that if equipment is designed so that physical limitations due to age are taken into account, the equipment will be even easier for younger miners to operate or maintain.

There are many physiological effects of aging. The table below describes how the male body changes each decade from the years 30 through 70. At age 30, hearing is already affected; by 40 the waist size has increased and stamina has greatly diminished; by 50 vision has begun to fail, particularly at close range; by 60 his height has shrunk by about 0.75 in (1.91 cm), he has trouble distinguishing between colors and tones, and his lungs can take in only about half what they could

**SOME OF THE EFFECTS OF AGING FOR A TYPICAL 5'10" (177.8 cm) MALE**

	AGE 30	AGE 50	AGE 60
<b>Weight:</b> .....	165 lb (74.84 kg) 15% fat	184 lb (83.46 kg) 30% fat	No data
<b>Vision:</b> .....	20/20	Needs glasses, more sensitive to glare, decreased depth perception	No data
<b>Work rate:</b> .....	1,110 lb (503.40 kg) (maximum pounds turned by crank in 1 minute where heartbeat returns to normal after 2 minutes rest)	950 lb (430.91 kg)	870 lb (394.63 kg)
<b>Right-handed grip:</b>	99 lb (44.91 kg) ...	92 lb (41.73 kg) ...	86 lb (39.01 kg)
<b>Left-handed grip:</b>	64 lb (29.03 kg) ...	58 lb (26.31 kg) ...	48 lb (21.77 kg)
<b>Waist:</b> .....	36 in (91.44 cm) ..	40 in (101.60 cm) ..	39 in (99.06 cm)
<b>Reaction time:</b> .....	0.88 sec	0.90 sec	0.92 sec (number of seconds elapsed until button is pressed after seeing 2 consecutive odd or even numbers on a screen)
<b>Blood flow rate:</b> ..	0.90 gal (3.41 L) ...	0.80 gal (3.03 L) ...	0.73 gal (2.74 L) (resting)
<b>Hearing:</b> .....	15,000 Hz	12,000 Hz	10,000 Hz (maximum level measured in Hertz)
<b>Air intake:</b> .....	1.5 gal (5.68 L) ...	1.13 gal (4.26 L) ...	0.90 gal (3.41 L) (maximum level measured in gallons)
<b>Heartbeat:</b> .....	200 bpm	171 bpm	159 bpm (maximum level measured in beats per minute)

when he was 30; and at 70 his heart is pumping less blood, his hearing is worse, and his vision is weakening further.

There never has been a thorough study on the aging miner and how safety and health are affected. No one has done any research on advanced mining technology, present and future, as it is related to the age of those who use or will be using it. Several studies have tried to see if there is any correlation between accidents and age in mining, but the results are inconclusive. The entire topic of age and worker safety and health in mining is

underresearched. As advanced technology is introduced more and more into mining, the effects of aging on safety and health could be exacerbated. Equipment designers should attempt to allow for these effects.

*Note: Females make up approximately 2% of the mining workforce. Also, there is less information on the effects of aging on females in the published literature.*

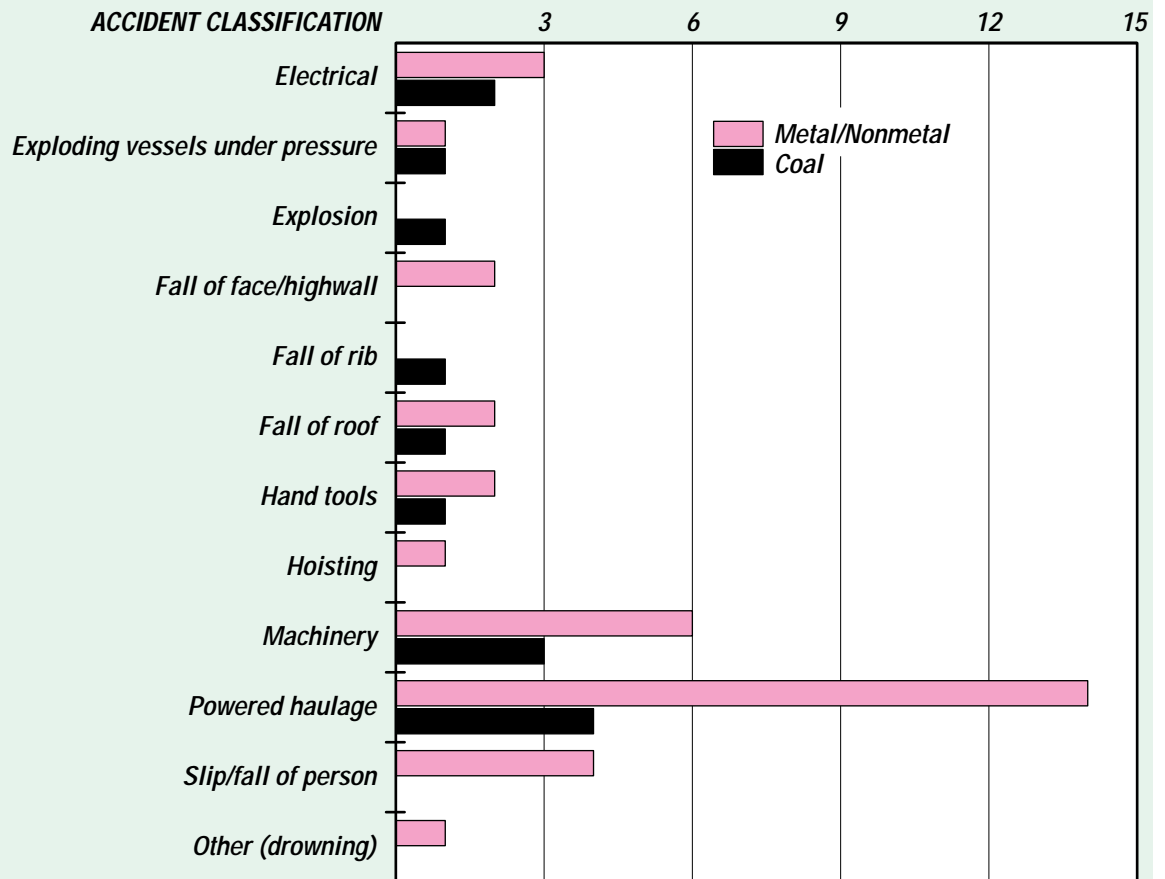
*Last modified October 7, 1996  
The human factors specialist listed below can help answer your questions about aging and the mining population:  
Richard S. Fowkes at rdf2@cdc.gov*



# Fatality summary, January through June 1997

## FATALITY SUMMARY, January–June 1997

Based on preliminary accident reports as of June 30, 1997



This article updates the status of fatalities occurring in both coal and metal/nonmetal mines from January through June of 1997. Based on preliminary accident reports, as of June 30, 1997, forty-nine fatalities have occurred at coal and metal/nonmetal mining operations. During this period, fourteen fatalities occurred at coal operations and thirty-six fatalities occurred at metal/nonmetal operations. Powered haulage fatalities in both coal and metal/nonmetal were the most frequent accident classification, causing 36 percent of the fatal

injuries; machinery accidents accounted for 18 percent of the fatalities.

Below is a summary of coal and metal/nonmetal statistics:

### Coal mining

Four of the fatalities were classified as powered haulage and 3 were machinery. Of the 14 fatalities, 6 occurred in West Virginia. Twelve fatalities occurred underground and two occurred on the surface.

### Metal/Nonmetal Mining

Fourteen of the fatalities were

classified as powered haulage, 6 were classified as machinery, and 4 were classified as slip/fall of person. Eight fatalities each, occurred at sand and gravel and limestone operations and 7 occurred at gold operations. Four fatalities each occurred in California, Nevada, and Florida and 3 fatalities each occurred in Arizona, Tennessee, and Missouri. Twenty-nine of the fatalities occurred at surface operations, the remaining 7 fatalities occurred at underground facilities.

Submitted by: John V. Forte, National Mine Health and Safety Academy

## Best practices for surface mines, POWERED TRUCK HAULAGE:

In 1996, coal and metal/nonmetal mine operators, surface haulage equipment manufacturers, and trade associations, along with representatives from the Mine Safety and Health Administration (MSHA) and the National Institute for Occupational Health, began working on preparing best practices for haulage trucks. These best practices were developed with the truck driver as the audience. The draft best practices developed by the group have been well received by persons associated with coal and metal/nonmetal mines. They are also being reviewed by MSHA's surface haulage training volunteers before they are finalized for presentation to the mining community. Because of the importance of disseminating this information as widely as possible, MSHA is presenting the information in several formats, including this publication.

### Brake systems

Brake systems on modern machines are provided with at least three braking functions: Service—secondary (emergency)—parking. Many machines are also equipped with a retarding brake system. The operator must fully understand the function and limitations of these individual brake systems as well as how and when to use them.

The service brake system is the main braking system used to bring the machine to a stop and hold it stationary.

Each brake system needs to be evaluated by each operator for proper function before beginning and during haulage operations. Any deviation from normal operation must be corrected.

The secondary (emergency) brake system is a back up system in case something happens to the normal

brake system. In many cases, it is of lesser braking capacity and should only be used to stop the machine in an emergency.

The parking brake system is a static applied brake to hold a stopped machine in place. The parking brake on some machines also serves as the secondary brake. If it is used as the secondary brake system, and applied to stop the machine, it must always be tested for parking capacity after such an incident. To test for parking capabilities, the machine must be loaded with a rated load on the maximum grade on which it was designed to park. Unless otherwise specified by the manufacturer, the maximum grade is 15%.

A retarder is a dynamic brake used to control the machine's speed while operating on down grades. The retarder may be utilized as part of the service brake system to provide the major part of normal braking.

Brake maintenance is to be performed in accordance with the manufacturer's instructions. The operator must check for proper fluid levels, and check that maintenance personnel are maintaining air reservoirs and compressors and inspecting friction components for wear.

Any evidence of overheating should be checked by an authorized person.

The manufacturer's operator's manual must always be considered to be the primary source of information for safe operation of any machine.

Any malfunction, defect or improper operation is to be checked by an authorized person to correct the problem.

### Steering systems

After the machine has warmed,

perform steering actions with the machine stationary or at a slow speed to determine if the control is responsive to input. Any feeling of looseness, binding, unusual noise, or stiffness in the steering control system should be evaluated by an authorized person.

Check for full left-to-right steering to ensure the steering system has its full range capability. Have any noticeable deficiencies evaluated.

Secondary (emergency) steering systems are generally provided on haulage machines. This system provides steering in the event the primary steering system fails.

Check the secondary (emergency) steering system in accordance with the manufacturer's operators manual. Noticeable discrepancies should be evaluated by an authorized person.

In most cases, there will be some kind of warning of impending failure of the normal steering system. Loss of hydraulic pressure, warning lights, buzzers, etc. There may be increased resistance to steering control and response of the system, or slack at the steering wheel.

Whenever the machine's normal steering system fails, and the secondary (emergency) system is activated, the machine is to be slowed down immediately and brought to a stop as quickly as it can be done safely.

The manufacturer's operator's manual must always be considered to be the primary source of information for safe operation of any machine.

Any malfunction, defect or improper operation is to be checked by an authorized person to correct the problem.

*Contributed by Doris Cash, MSHA  
Technical Support*

# 20

## Ward Lucas and Jodi Black join elite group

At right, Ward Lucas, BHP Mine Senior Safety Coordinator at San Manuel, Ariz., receiving award from Chuck Gessner, Director of Safety and Health for BHP.



At right, Cliff Mull, Senior Safety Administrator at St. Paul OCIP, program for contractor safety (working on Phelps Dodge Morenci property) congratulating Jodi Black on receiving her certification as a mine safety professional.



Ward Lucas, Senior Safety Coordinator for BHP Copper Company, San Manuel, Arizona and Jodi Black, Loss Control Service Representative working on the Phelps Dodge Morenci Inc. property, Morenci, Arizona, have joined the elite of mining safety professionals.

The International Society of Mine Safety Professionals is an organization dedicated to promoting the ongoing professional development of the safety professionals in the mining industry. The society also offers certifications for achieved skill levels for mine safety professionals.

Ward and Jodi decided to take on the challenge presented by the society to achieve certification. Ward and Jodi's years of experience and broad body of knowledge made the process a bit easier, but it still involved hundreds of hours of research and study which culminated in a tough, two-day, 16-hour exam, the bulk of which

consisted of essay-type questions.

After the exam, both Ward and Jodi stated that they had refreshed a lot of their knowledge and learned many new things just studying for the exam and taking it.

When the grading was completed and the results were tallied, Ward Lucas and Jodi Black have officially achieved the highest level of certification possible from the society. Both have received the professional designation of Certified Mine Safety Professional from the International Society of Mine Safety Professionals. This is truly an elite group, numbering only about two dozen Arizona wide.

Ward and Jodi continue to set the standard for what being a mining safety professional means.

Congratulations to Ward and Jodi for a job well done.

*Submitted by H.L. Boling*

## Virtual Reality technology

*AIMS Research Unit, Minerals Industry Applications*

Until recently the mining industry has had a very 'traditional' attitude to safety, environmental concerns and new design methods. Minerals companies are were concerned more about compliance with industrial law rather than providing for the health and well-being of those that worked in the industry or caring for the environment around their operations (Staley, 1992). Attitudes towards industrial safety, environmental aftercare and industrial design have advanced significantly in recent years and the mining industry has not been an exception to this. The introduction of new safety and environmental legislation in the UK has changed the emphasis of industrial law from

prescriptive legislation into new management systems.

Most mining companies reacted to these new pressures and developed initiatives by introducing modern management philosophies (Staley, 1992). A range of new techniques have been applied to try and meet the new legislative and production demands.

Large mineral organizations are now continually looking for ways to improve their performance. Any new technologies which may help need to be explored. The rapid advances in computer graphics and Virtual Reality provide a very 'real' way in which complex ideas and information can

be transmitted to a work force or to the general public. These new techniques allow videos, simulators, and planning systems to be developed quickly, efficiently, and relatively inexpensively. The capacity to remember information from a three dimensional computer environment is far greater than the ability to translate information from a printed page into a 'real' three dimensional environment. This understanding enhancement has been extensively discussed by a number of authors (Rheingold, 1991 and Krueger, 1991).

*Reprinted from the AIMS Research Unit—1996.*

## Conesville Coal Preparation Company honored for safety achievement



Pictured (from left): Randy Miller, Sen. James Carnes, Rep. Joy Padgett, Mark Roberts

Conesville, Ohio, June 5, 1997—Conesville Coal Preparation Company employees were recognized at a recent meeting of the MidOhio Chapter of the Holmes Safety Association for working more than 1,000 days without a lost-time accident.

The plant's 40 employees reached the 1,000-day mark in November

1996 and are now approaching 1,200 accident-free days.

The Holmes Safety Association is affiliated with the Mine Safety and Health Administration.

State Sen. James Carnes (R-St. Clairsville) and State Rep. Joy Padgett (R-Coshocton) presented resolutions passed by the Senate and House of Representatives recognizing Conesville

Coal Preparation Company on the achievement. They were presented to Randy Miller, preparation superintendent, and Mark Roberts, president of United Mine Workers of America Local 1366.

Contact: David Hagelin, Corporate Communications Manager, (614) 687-3022

## Properly ventilating or checking tank prior to welding could have prevented fatal explosion

Failure to ventilate a sealed tank or test it for flammable or explosive gases prior to beginning welding operations was the cause of a March 6 fatal accident.

The accident at Richardson Road Quality Aggregates, Inc. a sand and shell operation in Sarasota, Fla., resulted in the death of a 27-year-old welder who had been with the company for 10 months.

The victim was assigned to weld a v-shaped metal tie-off on to both ends of two metal flotation tanks; the two tanks were supposed to be installed on the dredge discharge line. He had finished welding the tie-off to one end of a tank and was

in the process of welding the tie-off to the other end when the welding rod burned through the tank. The tank exploded and he was thrown 26 feet backwards by the end of the tank as it separated from the tank itself. His death was attributed to multiple blunt force trauma caused by the explosion.

MSHA's report on the accident noted that the tanks delivered on the date of the accident were sealed and the interior had been painted with a rust-inhibiting paint at the order of the mine operator. A copy of the Material Safety Data Sheet for the paint stated: *Do not pressurize, cut, heat, weld or expose such contain-*

*ers to flame. They may explode and cause injury or death.*

MSHA said there were no warning labels on the tank and that the paint had a flashpoint of 103°F

MSHA issued a citation for an alleged violation of §56.4604 for failing to ventilate the tank and for failing to determine whether the tank held flammable gases.

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## Quarry safety programs

Experts say an effective safety program requires a number of critical elements.

By Mark S. Kuhar

You can discuss safety theory all day long, buy personal protective equipment for every employee and hold toolbox safety meetings each morning, but all of that will be for naught if safety is not a core company value that starts at the top.

The critical foundation on which an effective safety program rests is commitment from management. Safety consciousness must be preached by top company officials if the company safety manager is to establish a program that works at ground zero.

"Preemptive changes must start at the top," says Dr. Ron G. Pritchard, P.E., a risk-management consultant with Alexander & Alexander. "Management has resources and communications that can be utilized to facilitate the implementation of change."

Jim Locker, a consultant with FMI agrees. "For the zero injury process to exist, management must believe in and commit to the result," he says. "Without this conviction, risky behaviors will continue and accidents will occur."

And don't kid yourself—employees know when management is just paying lip service to a subject. The commitment of management must be specific, loud and clear.

According to the experts, safety goals and practices should be incorporated into the company business plan. Putting a commitment to safety in writing and showing how it integrates with the rest of the company mission demonstrates beyond a shadow of a doubt that safety is not to be taken lightly.

"The best practice is to involve all the elements as a bundle," Pritchard says, "and tell employees we must do them all to achieve success." Thus begins the cultivation of an active safety culture within the company.

### Line of responsibility

With a firm corporate commitment in place, a line of responsibility must be set up. This means appointing a full-time safety manager who reports to management. In cases where a quarry has multiple operations, a corporate safety manager should have a site safety manager at each operation.

Both safety managers and the employees they are supervising must be properly educated in regard to safe work practices and expectations of achievement.

According to Peter Ward, safety director at Benchmark Materials, MSHA certification is important to this process. "The MSHA certification process is provided free of charge by the state or federal government depending on where you live," he says.

The education provided by MSHA can be supplemented by many other types of training programs. Consultants, such as *Pit & Quarry* safety editor Carl Metzgar offer seminars and training programs. There are also formal programs offered through the National Safety Council, and other national associations. Toolbox safety talks can be used to actively promote safety within the ranks.

Whatever programs are used, one thing is important: employees must set high standards, and know what is expected of them. It is also helpful if employees are brought into the process of training and the correction of unsafe behaviors. Experts say that employees are quicker to adapt to safe work practices if they feel that they are helping to drive safety as opposed to being ordered to achieve it.

### Eliminating hazards

A good safety manager will be adept at recognizing hazards in the work

environment, and taking steps to correct them. Whether it is equipment guarding, electrical safety, safe equipment operation, or a maintenance-related issue, risk to employees is minimized by eliminating potential hazards before they cause injury.

Richard L. Seago, manager, corporate safety administration for Vulcan Materials, said in a safety and health seminar at last year's MINExpo that the following recommendations can help meet the challenge of preventing accidents:

- Acquire the skills to identify and effectively eliminate hazards.
- Spread those skills across the work force and supervisory ranks.
- Cross fertilize with other industries to develop safety expertise.
- Improve employees' technical job skills.
- Teach and practice effective safety planning to address hazards before accidents occur.
- Build a safety culture that allows all of these things to become valued as a way of doing business.

Finally, rewarding safe behavior is a way to cultivate safety in the ranks. While some people promote formal safety-incentive programs, and others think they just encourage the withholding of injury data, the idea that employees should be compensated for safe behavior pulls a lot of weight.

A cash bonus, prizes, or an awards program such as the one sponsored by the National Stone Association and *Pit & Quarry*, can provide needed recognition and thanks for a job well done.

Reprinted from the July 1997 issue of *Quarry Safety and Pit & Quarry*.

## Welding fumes sampling

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The potential hazards of welding operations include metal fumes, toxic gases, and ultraviolet and infrared radiation. Fume particles are formed from vaporization of molten metal. They are very fine in size, generally one micron or smaller, and may join together to form larger particles. Fumes can be sampled by drawing air through a special filter at a controlled rate. The adverse health effects of overexposure to welding fumes and gases include chronic or acute systemic poisoning, metal fume fever (a short-term painful ailment with symptoms of fever and chills), pneumoconiosis (lung disease due to accumulation of mineral or metallic particles), and irritation of the respiratory tract.

The welding fumes produced at welding operations depend primarily on the composition of the metals being welded and the welding rods. When the base metal is iron or steel, with welding rods of similar composition, the main component of the fume will be iron oxide. When welding on stainless steel, fumes containing nickel and chromium may be produced. Welding on plated, galvanized, or painted metals may generate fumes containing cadmium, zinc oxide, or lead. In addition, welding rods can generate fluoride in the fume as well as free silica, depending on the composition of the welding rod coating. In summary, welding processes may generate many different metal fumes and other toxic components. It is important that the hazards of a welding operation be evaluated properly. Toxic gases that arise in welding include carbon monoxide, nitrogen dioxides, and ozone. If welding or cutting

operations are conducted in the presence of chlorinated hydrocarbons, such as the form of solvents either on the metals or in the air, hazardous concentrations of phosgene and hydrogen chloride, which are highly toxic irritant gases, may be produced.

In addition to the health hazards of metal fumes and toxic gases, welding operations involve the hazard of burns from flame, arc, molten metal, and heated surfaces and also that of metal splatter. Welding operations in general require face, neck and eye protection for the welder—against sparks, splatter of molten metal, and the radiations (ultraviolet, infrared, and intense visible) of the arc or flame. Normally this means that a welder will wear a welding hood, or helmet, though in some cases gas welding may properly be done with adequate goggles, gloves, and other protective clothing of neck and arms. When personal respiratory protection is required, this may be provided by a supplied-air welding hood or when the components and concentration of the fume are known, by a filter-type respirator with filter for protection against fumes. It is preferable, of course, that adequate ventilation be provided so as to make the use of respirators unnecessary.

When sampling for welding fumes, the inspector will use a filter-cassette placed on the collar or shoulder so that it is beneath the helmet when the helmet is placed down. The sampling pump is fastened to the belt. Samples may be full shift or short-term. Short-term samples may be taken to evaluate toxic components which have short-term limits. In addition, the

inspector may sample for toxic gases such as ozone, nitrogen oxides, or phosgene. It is important that the welder carry out the welding operation in a normal way, so that an accurate evaluation of the exposure can be made. The inspector will attach and remove the filter cassette and pump as required.

Normally, good local or general ventilation is required to control exposures to the metal fumes and gases of welding operations. The most effective control is local exhaust ventilation in which an exhaust hood is placed near the welding arc or flame, and the contaminants are drawn away from the welder's breathing zone. The system may consist of moveable exhaust hoods, flexible and stationary ducts, a powered fan, and a fume or dust collector. Exhausted air should be discharged to the outdoors. If possible, it is important that, during the welding operation, the exhaust hoods are placed or set so that welding fumes are not drawn across the worker's face or into the breathing zone. Good general ventilation should be provided. Welding in confined spaces such as tanks, cabs of mobile equipment, and large shovels may be especially hazardous and require additional ventilation.

If you have any questions about this or any other occupational health matter, feel free to ask us. Our job is protecting your health.

URL: <http://www.msha.gov/S&HINFO/HHICM10.HTM>  
Contact: Mine Safety and Health Administration, Metal and Nonmetal Health Division, 4015 Wilson Boulevard, Arlington, Virginia 22203-1983, Phone: 703-235-8307

## Visibility, equipment problems figure in shuttle accident

Equipment problems and the fact that shuttle car drivers had a hard time seeing where they were going contributed to an underground coal death last fall in West Virginia.

The victim, a 21-year-old miner with 11 months experience, was crushed when his shuttle car was struck by another shuttle car at Cedar Point Mining Inc.'s No. 1 mine on Sept. 30, 1996.

"It was determined that both shuttle-car operators were seated in the operator decks facing inby and were operating the shuttle cars by looking over their shoulders while tramming outby," the MSHA report stated. "Tramming the shuttle cars in this manner restricts visibility of the operator's side of the shuttle car and causes the operator to have his back turned to the operator's side coal rib."

### Both shuttle cars loaded at time of crash

In addition to being issued a safeguard for having drivers not facing the direction of travel, a violation of 75.1403, there were equipment problems with both of the Joy shuttle cars involved in the accident.

The No. 2 left-drive Joy 21 SC shuttle operated by Duncan was not kept in safe operating condition, a violation of 75.1725(a), and the emergency parking brake on the same unit would not immediately activate when the panic bar was struck. The other car in the accident—driven by continuous miner helper Keith Norman—was cited for the same defects.

The accident happened in early afternoon. The victim was transported

to the surface where he was attended to by his father—the mine superintendent—and others, until the Mingo County Ambulance Service arrived at 2:12 p.m. He was flown by helicopter to a hospital in Huntington where he was declared dead at 4:18 p.m.

The fatality report was issued through MSHA District 4, Earnest Teaster, Manager, 100 Bluestone Rd., Mount Hope, W.Va. 25880.

*Reprinted from the June 16, 1997, issue of the Mine Regulation Reporter—Copyright 1997 by Pasha Publications Inc., Wayne Barber, Editor, 1616 N. Fort Myer Drive, Suite 1000, Arlington, VA 22209. Telephone: 703-528-1244, 800-424-2908, FAX: 703-528-4926, E-mail: minereg@pasha.com, Hotline Service: 703-816-8643.*

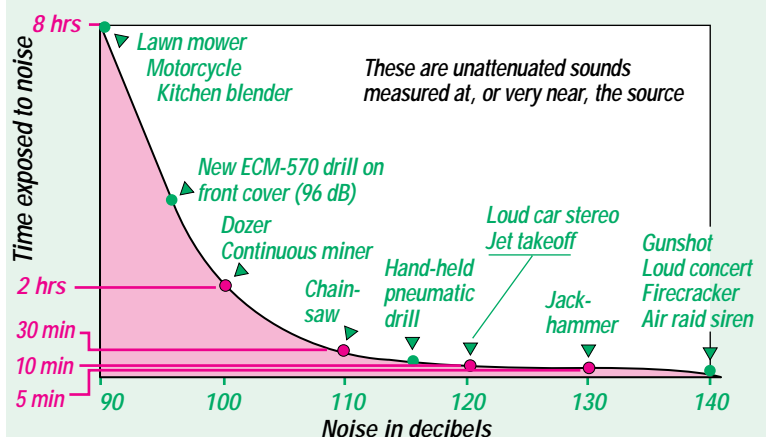
## Ear pollution

By Sandra G. Boodman

Hearing loss afflicts approximately 28 million people in the United States, according to the National Institutes of Health, and about 10 million of those impairments are at least partially attributable to damage from exposure to loud sounds. Taking steps to prevent prolonged exposure to potentially damaging noise is essential, health experts say, because there is no cure for noise-induced hearing loss. Very loud sounds, such as an explosion or gunfire, can cause permanent hearing loss almost instantly. But longer periods of

### What's a safe noise level?

The louder the noise, the less time it takes to cause harm



SOURCES: Health News; U.S. Occupational Safety and Health Administration; NIH

exposure to any sound louder than 85 decibels will eventually cause damage.

*Reprinted from the August 19, 1997 issue of the Washington Post Health magazine.*

**Warning: Winter Alert begins October**

## Back to basics for a healthy spine

Low back pain eventually strikes 8 out of 10 adults, so chances are it has laid you low or affected someone you know. Back pain used to dictate days or even weeks of bed rest, but no longer. For most patients, doctors now advise cautiously continuing normal activities.

Most episodes of low back pain pass quickly. Call your doctor if severe symptoms last longer than a couple of days or hamper your daily activities. Seek help immediately if back pain affects bowel or bladder control, if your groin or rectum gets numb, or if your legs feel weak.

The good news: You can prevent back pain from occurring or recurring by staying fit and by following “be-kind-to-your-back” rules. You can also strengthen at-risk muscles by exercising.

### Stand tall

Good posture is one of the best ways to prevent low back pain. Remember your gym teacher’s instructions? Assume your full height, hold your head up and pull your tummy in. Avoid sticking out your buttocks or arching your back.

Don’t stand tall in high-heeled

shoes, though. These can punish your back by pushing you into poor posture. Instead, choose comfortable, low-heeled shoes or flats.

### Lift and carry properly

When lifting anything, always bend your knees so you hoist the load with your sturdy thigh muscles, not your vulnerable back. For support and balance, keep your feet apart and lined up under your shoulders. Don’t twist, bend forward or reach while lifting. Carry heavy objects close to your body.

### Take care of your back at work

If you have to sit at work all day, take regular breaks to give stiff muscles a welcome stretch. Your work surface should be at a comfortable height, and your chair should support your lower back. For additional support, place a pillow or rolled-up towel at the small of your back. Rest your feet flat on the floor or on a footrest. If you must stand for prolonged periods, try placing one foot on a low stool.

### Try sleeping on your side

Experts advise sleeping on your

side with your knees drawn up or with a pillow between them. If you sleep on your back, place pillows under your neck and knees.

Stomach sleeping can stress a weak back. If you’re a confirmed stomach sleeper, put a pillow under your abdomen to help protect your back.

### Exercise wisely

Avoid exercises that strain your lower back, such as double leg lifts with straight legs, classic sit-ups, hip twists, toe touches and backward arches.

Regular aerobic exercise strengthens your back—and the rest of your body. Try brisk walking, swimming, stationary biking or cross-country skiing. In addition, add a few exercises to your routine that specifically target back, abdominal and leg muscles. The exercises described below can improve the muscle strength and flexibility you need to maintain good posture.

*Reprinted from the Fall 1997 issue of Georgetown University Medical Center’s Healthy Decisions.*

*The GU Center is located at 3800 Reservoir Road, N.W., Washington, DC 20007 Telephone: 202-784-4234*

### Two exercises for a healthy back

The pelvic tilt, the most commonly recommended back exercise, strengthens abdominal muscles and stretches the muscles of the lower back. The knee raise stretches your lower back and the hamstring muscles of your thighs.

Begin both exercises by lying on your back on the floor, with your knees bent and your feet flat.

#### Pelvic tilt

- As you exhale, press the small of your back to the floor.
- Hold this position for 5 seconds.
- Relax and repeat, building up to 10 times daily.
- You don’t need a floor to perform the pelvic tilt! Try performing the tilting motion while sitting, standing or on your hands and knees.

#### Knee raise

- Pressing the small of your back to

the floor, pull one knee to your chest with your hands.

- Hold for 5 seconds, then slowly lower your leg.
- Repeat 10 to 20 times daily with each knee.
- Vary by raising both knees to your chest.

If your back muscles feel tight at first, try doing these exercises after taking a warm bath or shower.





# Holmes Safety Association Officers and Executive Committee 1996-1997

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*We are short of articles on metal/quarry safety welcome **any** materials that you submit to the Holmes Safety Association Bulletin. We **DESPERATELY NEED** color photographs (8" x 10" glossy prints are preferred however, color negatives are acceptable—we will make the enlargements) for our covers. We **ALSO NEED** color or black and white photographs of general mining operations—underground or surface. We cannot guarantee that they will be published. If they are, we will credit the contributor(s) in this space and adjacent to the photo within the magazine. All submissions will be returned unless indicated.*

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## **Upcoming events:**

- **Oct. 9-10, Kentucky Mining Institute Annual Meeting/Exhibit, Lexington Convention Center, Lexington, KY**
- **Oct. 28, Iowa State Council Holmes Safety Association, Holiday Gateway Inn, Ames, IA**
- **Nov. 2-7, Impact of Mineral Impurities in Solid Fuel Combustion, Kona, HI**
- **Nov. 30-Dec. 3, 33rd Annual International Cement Seminar; Century Plaza Hotel, Los Angeles, CA**
- **Dec. 14-16, Louisville Construction/Mining Expo, Kentucky Fair/Expo Ctr., Louisville, KY**

